PATENT SPECIFICATION (11) 1 432 888

(21) Application No. 31023/74 (22) Filed 12 July 1974 (19)

(31) Convention Application Nos. 735 327 (32) Filed 6 Aug. 1973
741 914 25 Mar. 1974 in

(33) South Africa (ZA)

(44) Complete Specification published 22 April 1976

(51) INT. CL.[2] B21K 25/00

(52) Index at acceptance
B3H 5C1D 5C1J 5C2B
F2G 24C R1

1 432 888

(54) IMPROVED METHOD AND APPARATUS FOR COMPRESSING SLEEVES ONTO STRUCTURAL RODS

(71) We, ZEITGEIST AG., a Swiss Body Corporate of Trust Firm Ernst Hunter, Baarer Strasse 77, 6302 Zug, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of and apparatus for fastening steel sleeves *in situ* to the adjacent substantially co-axially disposed ends of reinforcing rods such as are used for structural purposes.

When structural reinforcing rods are positioned prior to casting concrete around them, it is a common practice to overlap the adjacent ends of rods which are disposed so that their longitudinal axes are substantially co-planar. The object is, of course, to minimise the risk of a weakness in the junction zone. This practice, is however, wasteful of steel.

To obviate this disadvantage, it has been proposed to accommodate adjacent rod ends in a steel sleeve and to crimp the sleeve onto the rods in a number of different parallel transverse zones by means of a hydraulic press. The chief disadvantage of this proposal lies in the fact that the necessary hydraulic equipment is usually bulky with the result that in many cases it cannot be manoeuvred into the required position because other reinforcing rods block access. It will be understood that the equipment must be positioned transversely with respect to the longitudinal axes of the rods.

It has also been proposed to effect a joint by compressing a steel sleeve onto the adjacent rod ends by means of an explosive charge. This proposal suffers from the disadvantage that it is noisy and is liable to damage or displace adjacent formwork and concrete.

If welding is resorted to, the operation is relatively slow and it requires a skilled welder to produce a good joint. Furthermore, he must necessarily use bulky equipment.

According to one aspect of the present invention there is provided a method of fastening *in situ* to adjacent substantially co-axially disposed reinforcing rod ends, a steel sleeve of uniform external cross-section throughout its length and having internal cross-sectional dimensions such that it can receive and embrace both rod ends, comprising the steps of locating the sleeve so that both rod ends are disposed within it; preventing the sleeve from moving longitudinally with respect to the rods; assembling around one of the rods in a zone outside that occupied by the sleeve a plurality of die segments which collectively provide a bore at least part of which is dimensionally smaller in cross-section than the external cross-sectional dimension of the sleeve; locking the die segments together, and applying a separate and independent thrust to each die segment to force the segments as a single unit along and over the sleeve to deform it and cause it to adhere firmly to the two rod ends.

Preferably, the sleeve is caused to adhere firmly to the two rod ends in a plurality of longitudinal zones which are circumferentially spaced one from the other.

We have found that it is highly advantageous to cause the sleeve to grip the rod ends only in a plurality of longitudinal zones which are circumferentially spaced from one another. Among the advantages flowing from this method of operation the following are of special significance:

(i) The joint is of adequate mechanical strength. Tests to destruction have shown that, provided the sleeve is suitably dimensioned, the rods will break outside the zone of the sleeve while the joint itself remains intact. In other words the rods will not pull out of the sleeve.

(ii) Less thrust is required to force the die over the sleeve.

(iii) There is a lower bursting force imposed on the die.

(iv) There is a smaller elongation of the sleeve.

(v) Less metal is required for the sleeve than would be required to obtain the same cross-sectional area after deformation if the sleeve were caused to grip the rods over their entire circumference.

(vi) There is probably less wear on the die.

The die segments may be forced along and over the sleeve by any suitable means. For example, mechanical means employing symmetrically disposed bolts and nuts may be used for this purpose.

We prefer, however, to employ fluid pressure, for example, air or particularly liquid pressure for moving the die segments.

Conveniently, a pair of complementary die segments may be used but it is within the scope of the invention to employ more than two for example, three or four segments.

In accordance with another aspect of the invention, we provide apparatus for fastening *in situ* to adjacent substantially coaxially disposed reinforcing rod ends a steel sleeve of uniform external cross-section throughout its length and having internal cross-sectional dimensions such that it can receive and embrace both rod ends, comprising at least two complementary die segments; locking means for temporarily securing the die segments one to the other so that collectively they provide an axial bore; and separate means associated with each die segment for moving the segments as a single unit in a direction parallel to the longitudinal axis of the bore.

While the means for moving the die segments may, as stated above in the description of the method of the invention, be mechanical or means activated by fluid pressure, we prefer to use hydraulic jacks for this purpose.

Preferably, a hydraulic jack or jacks is or are associated with each die segment and means are provided whereby the jacks may be located with respect to rods.

Either the piston rods or the cylinders of the jacks may be caused to move on the application of fluid pressure while the other jack elements remain stationary, in order to force the die segments along and over the sleeve.

The jack or jacks associated with each die segment may be supported by a mounting plate disposed in parallel spaced relationship to the die segment in question and the mounting plates may be adapted collectively to embrace one of the rods.

The mounting plates may be formed with or have fixed thereto stop means to engage one end of the sleeve and prevent it from moving axially relative to the rods.

The stop means may be of such external cross-sectional dimensions that it is able to pass into the bore of the composite die and so ensure that the sleeve is deformed throughout its entire length.

While the bore of the composite die may be of any cross-section capable of deforming the sleeve for the purpose stated, a plurality of complementary die segments may be provided for deforming a sleeve and causing it to adhere firmly to adjacent substantially co-axially disposed reinforcing rod ends, which collectively provide a bore having axially disposed inwardly extending ribs and in the circumferential zones between the ribs axially disposed recesses or pockets into which surplus material from the sleeve may be caused to flow as the segments travel along the length of the sleeve.

The ribs and recesses will normally be arranged symmetrically and it will be appreciated that the cross-sectional dimensions of the peripheral zone defining the faces of the ribs will be smaller than the external cross-sectional dimension of the sleeve, whereas the cross-sectional dimension of the peripheral zone defining the bases of the recesses will be larger.

Using die segments as described above, the sleeve will be caused to adhere to the rod ends only in a plurality of circumferentially spaced longitudinal zones. For example, a sleeve which is initially of circular cross-section may be deformed into substantially square cross-section with rounded corners.

In order that the method and apparatus of the invention may be clearly understood, reference will now be made to the accompanying drawings which illustrate, purely by way of example, one form of apparatus and the manner in which it is employed.

In the drawings:—

Fig. 1 is an oblique view of one form of apparatus for fastening a sleeve onto adjacent rod ends constructed in accordance with the invention,

Fig. 2 is a part sectional elevation of the apparatus of Fig. 1 assembled to the rod ends.

Fig. 3 is a plan view of two complementary die segments on an enlarged scale,

Fig. 4 is a longitudinal sectional elevation through the die segments on the line IV—IV of Fig. 3,

Fig. 5 is an oblique view showing the sleeve assembled to two adjacent rod ends before deformation of the sleeve,

Fig. 6 is an oblique view showing a sleeve assembled to two adjacent rod ends after deformation of the sleeve,

Fig. 7 is a cross-section on the line VII—VII of Fig. 5,

Fig. 8 is a cross-section on the line VIII—VIII of Fig. 6.

Referring to the drawings, the apparatus is constructed in two separate halves which may be secured together by locking means

such as latching elements 1 around the rods 2 and 3 and their embracing sleeve 4.

Each half includes a die segment 5 to which the free ends of piston rods 6 of hydraulic jacks are fixed. The jack cylinders 7 are secured to a recessed mounting plate 8 disposed in parallel spaced relationship to the die segment 5. The piston rod 6 project through the mounting plate 8. The mounting plates 8 are formed or provided with depending spigot elements 9 which are adapted to abut against one end of the sleeve 4 and prevent it from moving longitudinally with respect to the rod ends. Furthermore, the cross-sectional dimension of the spigot elements 9 is such that they can pass into the bore of the die and so enable the sleeve to be deformed throughout its entire length.

The mounting plates 8 are provided with radially disposed threaded holes 10 which receive bolts 11 by means of which the two halves of the apparatus are located with respect to the rod 2. It will be understod that these bolts merely serve to position the apparatus and that the clamping force exerted thereby does not have to resist the hydraulic pressure to be applied.

The die segments 5 collectively provide a bore 12 at least part of which is dimensionally smaller in cross-section than the external dimension of the steel sleeve 4.

Fig. 2 shows the manner in which the two halves of the apparatus are assembled to the rods 2 and 3. When fluid under pressure is admitted to the annulus sides of the pistons 13 of the hydraulic jacks, the die segments 5 will move towards the mounting plates 7. Such movement will cause the composite die to deform the sleeve 4 throughout its entire length so that it adheres firmly to, and forms a joint between, the rods 2 and 3.

Figs. 3 and 4 illustrate a preferred form of the die for use with the apparatus of the invention. The die comprises two complementary segments 14 and 15 which, when assembled together, provide an axial bore 16. The bore 16 is formed with four axially and symmetrically disposed inwardly extending ribs 17 and the diameter measured between opposed pairs of ribs is less than the external diameter of the sleeve 4. In the circumferential zones between adjacent ribs, the bore is formed with axially disposed recesses or pockets 18. The distance between the bases of opposed pairs of recesses is greater than the external diameter of the sleeve 4.

When a die as described above is used, the sleeve will be caused to adhere firmly to the rod ends in the longitudinal zones defined by the ribs 17. At the same time, surplus material from the sleeve will be caused to flow into the recesses 18. In the result, an initially cylindrical sleeve will, after the die has passed over it, have a substantially square cross-section with rounded corners.

The effect of the use of such a die is clearly apparent from a consideration of Figs. 5 to 8. As shown in Figs. 5 and 7, the sleeve 4 before deformation is of circular cross-section, internally and externally. It may, if desired, be coated internally with a high friction compound such as alumina grit. It embraces the adjacent ends of rods 2 and 3 which in this case are formed with ribs. If plain round bars are used an insert e.g. a hard steel spring (not shown) may be interposed between the sleeve and the rods to increase friction.

As is apparent from Figs. 6 and 8, after deformation the sleeve is cause to adhere firmly to the rods only in the circumferentially spaced zones 19 which are formed by the die ribs 17. Surplus material from the sleeve is forced into the intermediate zones 20 the location of which corresponds with the die recesses 18. As shown clearly in Fig. 8, there are zones 21 in which the peripheral surface of the rod is spaced from the internal peripheral wall of the deformed sleeve.

Although the embodiment described with reference to the drawings uses two die segments only, more than two segments can be used if desired. For example, three segments each providing 120° of the bore, or four segments each providing 90° of the bore may be employed. In general, however, there will be no necessity to employ more than two die segments each providing 180° of the bore.

WHAT WE CLAIM IS:—

1. A method of fastening *in situ* to adjacent substantially co-axially disposed reinforcing rod ends, a steel sleeve of uniform external cross-section throughout its length and having internal cross-sectional dimensions such that it can receive and embrace both rod ends, comprising the steps of locating the sleeve so that both rod ends are disposed within it; preventing the sleeve from moving longitudinally with respect to the rods; assembling around one of the rods in a zone outside that occupied by the sleeve a plurality of die segments which collectively provide a bore at least part of which is dimensionally smaller in cross-section than the external cross-sectional dimension of the sleeve; locking the die segments together, and applying a separate and independent thrust to each die segment to force the segments as a single unit along and over the sleeve to deform it and cause it to adhere firmly to the two rod ends.

2. A method according to claim 1, in which the sleeve is caused to adhere firmly to the rod ends in a plurality of longitudinal zones which are circumferentially spaced one from the other.

3. A method according to claim 1 or 2, in which the die segments are forced along and over the sleeve by mechanical means.

4. A method according to claim 1 or 2, in which the die segments are forced along and over the sleeve by fluid pressure actuated means.

5. A method according to claim 4, in which the die segments are forced along and over the sleeve by hydraulic means.

6. Apparatus for carrying out the method of any one of claims 1 to 5, comprising at least two complementary die segments; locking means for temporarily securing the die segments one to the other so that collectively they provide an axial bore; and separate means associated with each die segment for moving the segments as a single unit in a direction parallel to the longitudinal axis of the bore.

7. Apparatus according to claim 6, in which the means for moving the die segments is mechanical.

8. Apparatus according to claim 6, in which the means for moving the die segments is actuated by fluid pressure.

9. Apparatus according to claim 8, in which the means for moving the die segments comprises hydraulic jacks.

10. Apparatus according to claim 6, including a hydraulic jack/s associated with each die segment and means for locating the jack/s with respect to the rods.

11. Apparatus according to claim 10, in which the jack/s associated with each die segment is supported by a mounting plate disposed in parallel spaced relationship to the die segment in question and the mounting plates are adapted collectively to embrace one of the rods.

12. Apparatus according to claim 11, in which the mounting plates are formed with or have fixed thereto stop means to engage one end of the sleeve and prevent it from moving axially relative to the rods.

13. Apparatus according to claim 12, in which the stop means is of such external cross-sectional dimensions that it is able to pass into the bore of the composite die and so ensure that the sleeve is deformed throughout its entire length.

14. Apparatus according to any one of claims 6 to 13, wherein the complementary die segments collectively provide a bore having axially disposed inwardly extending ribs and in the circumferential zones between the ribs axially disposed recesses or pockets.

15. Apparatus according to claim 14, in whihc the ribs and recesses are arranged symmetrically.

16. A method of fastening *in situ* a steel sleeve to adjacent substantially co-axially disposed reinforcing rod ends substantially as herein described with reference to the accompanying drawings.

17. Apparatus for fastening *in situ* a steel sleeve to adjacent substantially co-axially disposed reinforcing rod ends substantially as herein described and illustrated in the accompanying drawings.

J. A. KEMP & CO.,
Chartered Patent Agents,
14, South Square,
Gray's Inn,
London, WC1R 5EU.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1432888 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

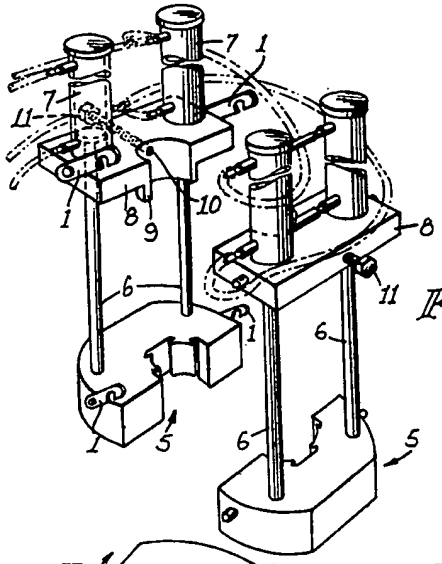
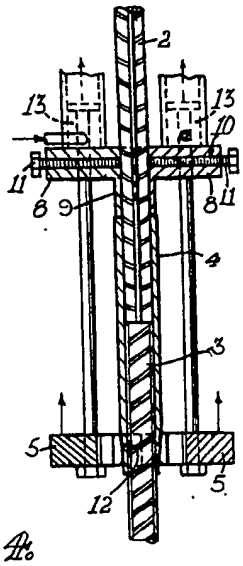


Fig 1.

Fig 2.



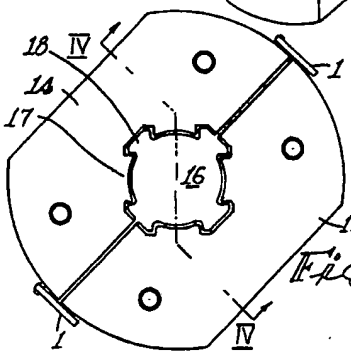


Fig 3.

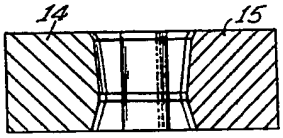


Fig 4.

1432888 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

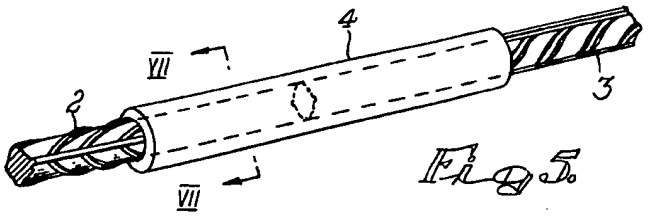


Fig 5.

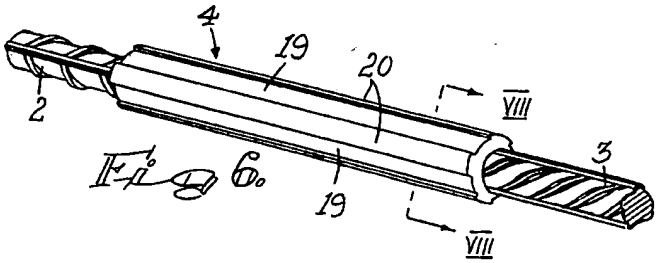


Fig 6.

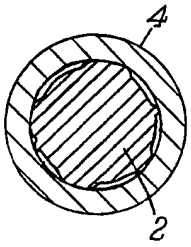


Fig 7.

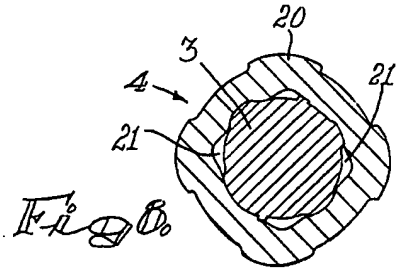


Fig 8.